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Feature Article

Sources of Lead Exposure in Granite City, Illinois

The Madison County Lead Exposure Study was part of a three-state study of lead and cadmium exposure at lead-contaminated Superfund sites. The sites consisted of two lead-mining sites and the Granite City site, which was a secondary lead smelter. Although cadmium data were also compiled to retain consistency in the research approach, lead was the only contaminant of concern at the Granite city location.

In 1991, the Illinois Department of Health (IDPH) and the Agency for Toxic Substances and Disease Registry (ATSDR) conducted a health assessment of the secondary smelter site. Based on results of this examination, the agencies concluded that a potential health risk existed. These findings, along with citizen concerns, prompted the exposure study in August 1991.

The target population comprised those residents living near the smelter site or in areas where contaminated by-products of the smelter were used on roadways and alleys. The objectives of the study were

- to determine lead levels in the blood of the target population and in environmental media,
- to determine the relationship between the blood lead levels in the population and the point source, and
- to evaluate the contribution of different environmental media to lead exposure in children.

The study involved 827 participants who came from 588 households in Granite City and the adjoining communities of Madison and Venice. Because of the inability to separate the comparison area geographically, the primary hypothesis for the Granite City study was whether lead in soil contributed significantly to blood lead levels in children. Regression analyses were used to statistically interpret the data compiled, a method that allowed researchers to analyze several variables simultaneously and to observe the influence of each variable on the others.

Results indicated that soil was not the most significant source of lead exposure. Based on the data analysis, household dust contributed the most to the blood lead levels of the study participants.

Selectivity in sampling

Of the participants, 490 were children between the ages of 6 months and 6 years. The oversampling of this age group was intentional because young children are more susceptible to the effects of lead. Previous research has indicated that children, because of their hand-to-mouth activities, ingest lead primarily through dust. They may also ingest lead from paint chips and from soil, food, air, and water.

As expected, the children had the highest blood lead levels of those participating. A distribution of the blood lead levels for children in the age groups studied shows that 16% of children had blood lead levels at or above the Centers for Disease Control (CDC) guideline of 10 micro-

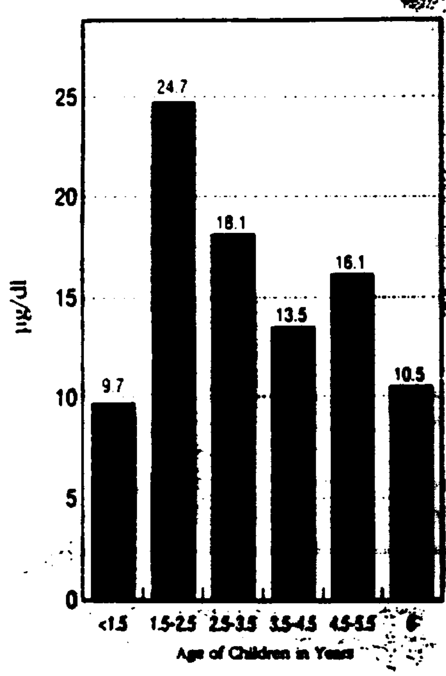
by David Webb, Illinois Department of Public Health

[illegible] lead levels between 6 months and 6 years old who had blood lead levels at or above 10 µg/dl is shown graphically in figure 1. Those from 1.5 to 2.5 years old had the highest percentage of individuals with blood lead levels at or above the 10 µg/dl level, suggesting that the best time for screening children for blood lead may be when they are within that age range.

Environmental contributions

What are the most important environmental factors in determining blood lead? The statistically significant ($p < .01$) correlations between blood lead and environmental contributors were lead in indoor paint; dust lead level; and dust load, defined as the weight of dust per unit area. Other statistically significant factors at $p < .01$ included the distance between a participant's home and the smelter; parents' education and income; number of smokers in the household and number of cigarettes smoked per day; number of hours played outdoors; and number of baths taken per week.

Figure 1. Percent of children with ≥ 10 µg/dl blood lead level



Source: ATSDR, 1994.

Based on our observations, the study concluded that household dust contributes the most to blood lead level of any of the known exposure variables, particularly when the dust loading is [illegible] dust. In effect, therefore, lead in house dust represents a significant pathway by which humans — especially children — are exposed to lead.

At first glance, it might appear as though soil is the most significant source of exposure to lead: Children's blood lead levels and soil lead levels were generally higher closer to the smelter and decreased with distance from the smelter, and the lead levels in both the soil and the children's blood were statistically significant. However, soil lead only accounted for 3% of the variance in blood lead. Nor did soil lead contribute markedly to the variance in dust lead. Compared with soil lead contribution, in fact, paint lead levels accounted for almost four times as much variance in dust lead.

These results suggest that the lead content of the paint and its condition made a much larger contribution to lead exposure than did the soil. In fact, lead in soil only contributed about 3% to total lead exposure, while lead in paint, and the condition of that paint, may have been responsible for as much as 11% of the total contribution.

However, only 37% of the total exposure could be accounted for. The remaining 63% of exposure to lead was not identifiable through the environmental contributors that we selected as variables. The source of this unexplained portion could be partly attributable to lead in food, air, imprecise blood and environmental lead measurements, dust load fluctuations, and variables pertaining exclusively to individual households.

Sidenotes and conclusions

The methods and conditions related to this exposure merit further attention. One must note, for example, that dust was only collected at one point during the study, and one dust sample alone may not represent dust levels throughout several months.

It is also important to keep in mind that the significant variables in this study, such as [illegible] such as [illegible] square tests and correlations could present misleading results.

Finally, confounding variables could not be adequately controlled for in this study, so individual factors were difficult to assess. House dust, for example, serves as a pathway of exposure for soil lead and house-paint lead in small children. In turn, many important behavioral variables could affect the degree of exposure to household dust.

• The Madison County Lead Exposure [illegible] personal and familial [illegible]. The study suggests that children between the ages of 1.5 to 2.5 years old may constitute the best population to screen for lead.

Perhaps the most interesting finding was that the greatest contributor to lead exposure in the vicinity of the smelter was not soil but dust. The results of this study and those of previous studies should be considered when determining a course of action to reduce lead exposure when the primary exposure source is thought to be soil.

[illegible] and [illegible] Charney et al. [illegible] Lead Poisoning: A [illegible] Trial of the Effect of Dust [illegible] Measures on Blood Levels. NEJM 309:1089-1093. 4) Laxen et al. 1987. The Variability of Lead in Dusts Within the Homes of Young Children. Environ Geochem Health 10: [illegible]

When is a hazard a threat?

It's hard to imagine that anyone with access to a TV set hasn't seen the public service announcement depicting a toddler sitting on the floor amidst chips of flaking paint, doing what toddlers tend to do: munching on one of the chips. The paint is lead-based, according to the voice-over, and the point of the TV spot is to warn parents of the dire — and possibly irreversible — consequences that are likely to befall children who ingest or are otherwise exposed to toxic amounts of lead, and to urge that all children be screened for lead poisoning.

There's no question that lead in sufficiently high doses can do serious damage to several human organs and systems — especially the nervous system — or that some of the damage may be done without [illegible] children are more vulnerable [illegible] children from low-income [illegible] vulnerable than those who live in [illegible] neighborhoods. In our feature article, David Webb of the Illinois Department of Health [illegible] some new data that help explain why that's [illegible] regulations are necessary.

[illegible] who suggest that [illegible] to regulate exposure to [illegible] mental lead might do as much harm as good. [illegible] is precisely the point made by the author of the commentary, Abraham Bergman. He argues that there are so few children who are exposed to lead in the state of Washington that requiring mass screening would exact economic and emotional costs far exceeding any benefit that might be derived.

Are mass screening and other strict regulatory measures justified? The EPA and the CDC believe they are. Webb suggests that the issue is a very complex one and that it's not always easy to determine where elevated levels of lead are coming from. (He does note that old paint is a significant culprit, but he also notes that his study failed to account for about two-thirds of the causative factors for lead poisoning.)

No one has suggested that lead isn't dangerous or that we don't need to protect children from exposure to it. But there is disagreement among reasonable people as to what kinds and what degree of protection is needed and whether it makes sense to apply blanket rules to populations whose exposures to lead (or any other pollutant) may vary widely. If a hazardous substance is not a threat in a particular community, perhaps it makes sense to apply a different regulatory approach. We don't have the answer, but we've tried in this month's feature article and commentary to illustrate the question. —DCB